EXPERIMENTAL EDITION

SCHOOL CHEMISTRY

CLASSES 9 & 10

Laboratory Manual

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Laboratory Manual

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PREFACE

This book is the concluding part of the series of books written for classes 6 to 10 by the Study Groups in Chemistry set up under the scheme envisaged by the National Council of Educational Research and Training, Ministry of Education, Government of India Being a sequential course, it is assumed that by the time the student enters class 9, he would be familiar with the elementary laboratory techniques and procedures in which he had been trained in the lower classes As such the emphasis in this laboratory manual has been on such experiments which will make the student familiar with the basic physicochemical principles and calculations In addition, a few experiments dealing with some important reactions of the major functional groups in carbon compounds have also been included It is hoped that this manual will not only give adequate training in understanding the basic principles of chemistry but also prepare the student for the next higher stage of education

It is a matter of regret that though the material for this book was ready long ago, paucity of funds and non-availability of paper have inordinately delayed its publication Happily, it is now being brought out in print.

The Directors and members of the Study Groups wish to convey their thanks to Shri Jayaraman, I A S., Joint Secretary, Ministry of Education, Government of India, Dr. S V C Iya, Director, N C.E R,T , Dr. M. C. Pant, Head, Department of Science Education and Dr. G. S. Baderia, Reader, for their keen interest in the work of the study groups and their cooperation. They also thank the Director, University Press, Osmania University, Hyderabad, for undertaking to get the book printed They appreciate the services of Shri G Sivaram, artist, for his illustrations

Finally, the Convener wishes to convey his deep appreciation to the Directors and members of the Chemistry Study Groups for their joint effort and unstinted cooperation in preparing the entire material for classes 6 to 10 under this scheme. If this material, prepared through the combined effort of so many individuals, will eventually contribute to the improvement of Science education in India at the School level, their labours would be deemed to have been amply rewarded

August, 1974,
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CONTENTS

1

The size of particles-I

Materials required

Balance

Weight box

1 cm cubes of a few metals

Procedure

Weigh a metal cube of, say, copper, to the nearest centigram Calculate the number of moles in it. Assuming that 1 mole of each element contains 6.0×10^{23} atoms and that they are spherical, estimate the number of atoms lying along the edge of the cube. From this calculate the approximate diameter of each atom.

Repeat the experiment with the cubes of a few other metals assigned to you by your teacher.

2

The size of particles-II

Materials required

Plastic tray (8x5x3cm)

Dropper

Cotton or silk thread (35 cm)

Half metre scale

Glass rod

Measuring cylinder (10 ml)

Candle wax

Solution of stearic acid in ether 5 ml (0.1g/litre)

Procedure

Wax a cotton thread by drawing it through the fingers greased with a little candle wax. Make a loop of it by tying the ends together. Fill a tray with water to a depth of 1 to 2 cm. Float the loop on the surface of water in the tray. Add stearic acid solution, dropwise, to the water surface within the loop until the loop is taut (fig. 1). After adding each drop, push the loop gently with a glass rod. If the loop gets dented, add a few more drops of the solution and push the loop every time, till there are no dents. Record the number of drops added. Measure the length of the thread forming the loop.

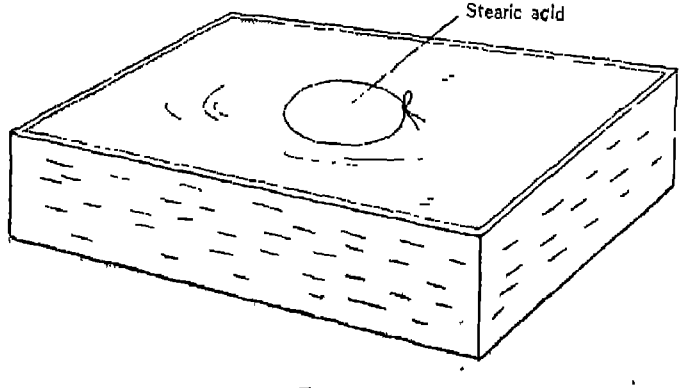

FIG. 1

Obtain the volume of one drop of the acid solution by counting the number of drops required to fill a measuring cylinder upto 1 ml mark.

From the above observations, calculate the size of a stearic acid molecule as shown below.

Calculations

Number of drops in one ml of the acid solution = n

Number of drops of the acid solution required to obtain a taut loop = N

The solution contains 0.1 g/litre of stearic acid. The density of stearic acid is approximately 1g / ml

i.e. 1000 ml of solution contain 0.1 ml of acid

$\therefore$ 1 ml of solution contains 0.1/1000 ml of acid.

i.e. n drops contain 0.1/1000 ml of acid.

$\therefore$ 1 drop of the solution contains $\frac{0.1}{n \times 1000}$ ml of acid.

Hence, N drops of the solution contain $\frac{0.1 \times N}{n \times 1000}$ ml of acid. ----(1)

Let the thickness of the layer formed when N drops of the acid solution are spread out on the surface of the water be t cm.

Circumference of the loop = l cm. (Assume that the loop is circular)

$\therefore$ radius $= \frac{L}{2\pi}$ cm.

Hence, area of the loop (A) $= \pi \left\{ \frac{L}{2\pi} \right\}$ sq. cm.

Volume of stearic acid in N drops of the solution = t x A .....(2)

We find from equations (1) and (2) that

$$t \times A = \frac{0.1 \times N}{n \times 1000}$$

$$t = \frac{0.1 \times N}{n \times 1000 \times A}$$

Assuming that a unimolecular layer is formed on the water surface and that a molecule is spherical in shape, the thickness of the layer may be taken as the diameter of the molecule.

3

Hydroxides of the elements of period three

Materials required

Deflagrating spoon
Pair of tongs
Glass plate
Wide-mouthed bottle
Evaporating dish
Glass rod

Litmus papers (red and blue)
Sodium
Magnesium ribbon
Phosphorus
Sulphur
Dilute hydrochloric acid
0.1M alum
Aqueous ammonia (1:1)
2.0M sodium hydroxide

Procedure

Take a piece of sodium metal, about the size of a pea, in a deflagrating spoon and heat it on a Bunsen flame till all the sodium burns off (fig. 2a). Cool the deflagrating spoon and dip it in a small quantity of water taken in an evaporating dish. The residue dissolves in water. Test the solution so obtained with red and blue litmus papers. Record your observations.

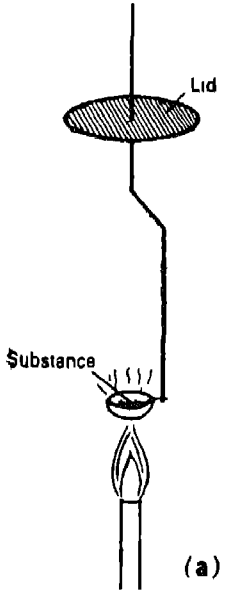

FIG 2 (a)

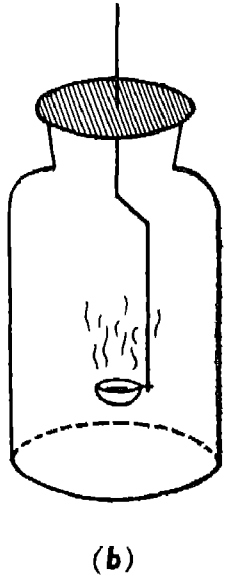

FIG. 2 (b)

Place a small quantity (about 0.3 g) of sulphur in a deflagrating spoon and ignite it in a Bunsen flame. When the sulphur catches fire lower the spoon into a wide mouthed bottle and allow the sulphur to burn off. (fig. 2b) Take the spoon out. Add 5 ml of water to the contents of the bottle, cover it with a glass plate and shake the contents. Test the solution with red and blue litmus papers and record your observations.

Repeat the experiment with phosphorus and record your observations (use phosphorus about the size of a match head).

Hold one end of a magnesium ribbon with a pair of tongs and ignite the other end over a Bunsen flame. Collect the ash in an evaporating dish. Add about 5 ml of water and stir with a glass rod. Test the solution with red and blue litmus papers. Record your observations.

Take 5 ml of alum solution in a test tube and add aqueous ammonia till a gelatinous precipitate of aluminium hydroxide is obtained. Warm the test tube and allow the precipitate to settle. Decant the clear liquid. Divide the precipitate into two parts. To one part add sodium hydroxide solution, dropwise, in excess. What happens?

To the other part add dilute hydrochloric acid, dropwise, in excess. What happens? What property of alluminium hydroxide is evident from your observations?

4

Investigation of the reactions of some cations

Materials required

Test tubes 6

Droppers

Blow pipe

Pen knife

Charcoal block

Watch glass

Platinum or

Nichrome wire

Conc. hydrochloric acid

0.1 M aqueous solutions of
potassium nitrate,
calcium nitrate,
barium nitrate,
magnesium nitrate,
aluminum nitrate,
ammonium carbonate,
cobalt (II) nitrate and
ammonium chloride

2.0 M sodium hydroxide
Aqueous ammonia (1:1)
Tartaric acid solution (saturated)
2.0 M ammonium sulphate

Solids

Sodium carbonate
Potassium nitrate
Magnesium sulphate
Calcium carbonate
Barium nitrate
Aluminium nitrate

Procedure

Carry out the following tests by taking 1 ml each of potassium nitrate, calcium nitrate, barium nitrate, magnesium nitrate and aluminium nitrate solutions in separate test tubes.

1. Add 3 to 4 drops of sodium hydroxide solution. Record your observations. Now add 3 ml of sodium hydroxide solution and shake. Note what happens.

2. Add 1 ml of aqueous ammonia. Record your observations. Now add excess of ammonium chloride solution (3 to 4 ml) and note what happens

3. Add 1 ml each of ammonium chloride, aqueous ammonia and ammonium carbonate solution and shake. Note what happens.

4. Add 1 ml of ammonium sulphate solution. Note what happens.

5. Add 1 ml of tartaric acid solution and shake. Note what happens.

6. *Charcoal test*

Scoop a cavity at the centre of a charcoal block (use a pen knife). Mix intimately about 0.2 g of powdered aluminium nitrate with an equal quantity of sodium carbonate on a piece of paper and place some of it in the charcoal cavity Moisten it with a drop of water and heat it in the reducing flame with the help of a blow pipe. (To obtain a reducing flame, close the airholes of the Bunsen burner and hold the jet of the blow pipe just outside the flame and blow gently). After heating for 3 to 4 minutes, note the colour of the powder. Moisten the powder with a drop or two of cobalt(II)nitrate solution and heat it again strongly in the oxidizing flame. (The oxidizing flame is obtained by opening the air holes and holding the blow pipe jet within the flame and blowing hard to get a full blast). Note the colour of the powder in the charcoal cavity. Repeat the test with the nitrates of potassium, magnesium, barium and calcium. Record your observations.

7. *Flame colouration*

Take a platinum or nichrome wire and clean it by heating it to incandescence in the hottest part of the flame of the burner. Dip the heated wire into about 5 ml of concentrated hydrochloric acid taken in a test tube and heat it again in the flame. Repeat this till the wire imparts no colour to the flame. Take a pinch of barium nitrate on a watch glass, moisten it with a drop of concentrated hydrocholric acid. Dip the wire in the

mixture and heat it in the flame (fig.3). Note the colour of the flame.

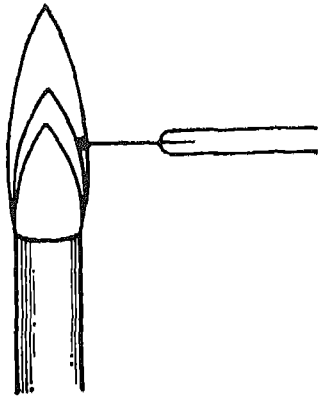

FIG. 3

Clean the wire as described before and repeat the test with nitrates of potassium, calcium, magnesium and aluminium.

	Reagent		K^+	Ca^{2+}	Ba^{2+}	Mg^{2+}	Al^{3+}
1.	NaOH	3 to 4 drops					
		excess					
2.	NH_3(aq)						
		$+NH_4Cl$					
3.	NH_4Cl+NH_3 (aq)$+$ $(NH_4)_2CO_3$						
4.	$(NH_4)_2SO_4$						
5.	Tartaric acid solution						
6.	Charcoal test						
7.	Flame test						

Questions

1. Which metal ions are precipitated as hydroxides when sodium hydroxide is added? Which of the precipitated hydroxides dissolve in excess of sodium hydroxide?

2. Which metal ions are precipitated as hydroxides when aqueous ammonia is added? Which of these precipitates dissolve on adding ammonium chloride solution.

3. Suggest a method for the separation of
   (a) aluminium ions from calcium ions,
   (b) aluminium ions from magnesium ions,
   (c) calcium ions from magnesium ions,
   (d) barium ions from calcium ions.

4. You are supplied with four packets containing, respectively, aluminium sulphate, magnesium sulphate, calcium chloride and barium chloride. How do your identify them by any of the above mentioned tests?

5

Bleaching powder

Materials required

Test tubes 3
Platinum or nichrome wire
Watch glass
Funnel
Funnel stand
Bleaching powder
Conc. hydrochloric acid
Filter paper
Litmus papers (blue and red)
Starch-iodide paper
Splinters
0.1 M ammonium carbonate
2.0 M sulphuric acid
0.1 M cobalt (II) chloride

Procedure

Smell the given sample of bleaching powder. What does it remind you of?

Take a small amount of bleaching powder in a test tube and add about 1 ml of dilute sulphuric acid. Identify the gas evolved by testing with litmus papers and starch-iodide paper.

To a small amount of bleaching powder taken in a test tube, add about 1 ml of water and shake Then add about 1 ml of cobalt (II) chloride solution and boil. Identify the gas evolved by testing with a glowing splinter.

To a small amount of bleaching powder in a test tube add about 1 ml of water and shake. Filter the solution and collect the filtrate in another test tube. Add to this about 1 ml of ammonium carbonate solution. A white precipitate is obtained. Filter and conduct the flame test with the precipitate (refer experiment 4). Note the colour of the flame. What is your conclusion?

Question

What elements are present in bleaching powder?

6

Hydration of plaster of Paris

Materials required

Test tube

Empty match box

Coin

Pen knife

Watch glass

Plaster of Paris

Vaseline

Procedure

Take about 3 g of plaster of Paris, $CaSO_4.1\frac{1}{2}H_2O$, in a test tube and add about 5 ml of water and shake Feel the test tube and note if there is any temperature change. Invert the test tube. What happens?

Grease lightly one of the faces of a coin with vaseline and place it at the bottom of a small match box, with the greased surface upwards. Fill the box with a thick, freshly prepared paste of plaster of Paris. Allow the mixture to stand for half an hour till it becomes hard. Then cut the bottom of the box and remove the coin. What do you observe on the plaster.

Question

From your observations suggest a use for plaster of Paris.

7

Calcium carbonate

Materials required

Test tubes 3

Beakers (100 ml) 2

Funnel

Funnel stand

Filter papers

Test tube holder

1.0 M sodium carbonate

1.0 M calcium chloride

2.0 M hydrochloric acid

Carbon dioxide generator

Procedure

Take 20 ml of the given calcium chloride solution in a beaker and warm it. Take 20 ml of sodium carbonate solution in another beaker and warm it. Now mix the two solutions by adding sodium carbonate solution to the calcium chloride solution. Stir well. Wait till the precipitate of calcium carbonate settles down. Filter the precipitate and wash with small amounts of hot water Dry the precipitate.

Remove the dry calcium carbonate from the filter paper and collect it on a piece of paper. Divide the dry powder into two parts.

Take one part in a test tube and add about 1 ml of dilute hydrochloric acid. What do you observe? What does this indicate?

Take the other part in another test tube. Add about 2 ml of water and shake. What happens?

Now pass carbon dioxide through the solution and note what happens? Explain your observations..

Question

Write the equations for

(i) The reaction between calcium chloride and sodium carbonate,

(ii) the reaction of calcium carbonate with dilute hydrochloric acid and

(iii) the reaction of calcium carbonate with carbon dioxide.

8

Action of air, water, alkali and acid on aluminium

Materials required

Aluminium wires (4 cm) 6
Beaker (250 ml)
Sand paper
Test tube
Splinters
0.1 M mercury (II) nitrate
2.0 M sodium hydroxide
2.0 M sulphuric acid
2.0 M hydrochloric acid

Procedure

Take two wires of aluminium and clean them with sand paper. Dip one of them in mercury (II) nitrate solution for about two minutes. Take it out, dry it with a filter paper and expose the two wires to air for about five minutes. Note if there is any change on the surface of the wires.

Clean the third aluminium wire with sand paper and dip it for two minutes in water contained in a beaker See if there is any reaction. Remove the wire from the beaker and immerse it in mercury (II) nitrate solution for about two minutes. Take it out and wipe it with a piece of filter paper and then dip it in water. Notice if there is any reaction. Explain your observations.

Take 2 ml of sodium hydroxide solution in a test tube and dip the fourth aluminium wire in it. Notice what happens. Introduce a burning splinter into the test tube and record your observations. Repeat this experiment with 2 ml each of dilute hydrochloric and sulphuric acid solutions. Record your observations.

9

Potash alum

Materials required

Beaker (250 ml)

Evaporating dish

Funnel

Filter paper

Tripod

Wire gauze

Burner

Glass rod

Funnel stand

Aluminium scrap

2.0 M potassium hydroxide

2.0 M sulphuric acid

Procedure

Take about 20 ml of potassium hydroxide solution in a beaker and add to it 1g of aluminium scrap in one lot Warm the contents gently. Once the reaction starts, stop heating and allow it to proceed. When the reaction subsides, filter the solution and collect the filtrate in an evaporating dish. To the filtrate add dilute sulphuric acid with constant stirring till the precipitated aluminium hydroxide just dissolves, giving a clear solution again. Concentrate the solution to a small bulk by evaporation and allow it to cool until crystals of potash alum separate. Decant the supernatant liquid and transfer the crystals to a filter paper and dry them. Preserve this sample for the next experiment.

10

Aluminium hydroxide as mordant in dyeing

Materials required

Conical flask (100 ml)
Funnel
Filter paper
Watch glass
Beaker (250 ml)
Piece of white cloth
Funnel stand
1.0 M potash alum
Aqueous ammonia (1:1)
Litmus solution
Alkaline solution of alizarin

Procedure

(a) *Preparation of aluminium hydroxide*

Place about 20 ml of aqueous ammonia in a 100 ml conical flask and add to this about 10 ml of potash alum solution. A gelatinous precipitate of aluminium hydroxide is formed. Note the colour of the precipitate.

(b) *Adsorption of a dye (alizarin)*

Pour 5 ml of alkaline alizarin solution into the conical flask containing aluminium hydroxide. Shake well. Note the colour of aluminium hydroxide. Filter. What is the colour of the filtrate? Explain.

(c) *Dyeing of a fabric*

Place a strip of a white cotton fabric on a watch glass. Moisten the strip with a few drops of the alum solution. Add a few drops of aqueous ammonia to the fabric. Wait for about 5 minutes. Wash the fabric with water. Make a mark for identification. Place it in a beaker containing an alkaline solution of alizarin. Take another strip of white cotton fabric and place it in the beaker along with the previous strip of the fabric for comparison. After 5-7 minutes wash both the strips thoroughly with water and compare their colours. In which case is the colour deeper? What does this indicate?

11

Borax beads

Materials required

Platinum wire (fused in a glass rod) 3 cm

Bunsen burner

Copper (II) sulphate
Manganese (II) sulphate
Nickel (II) sulphate
Iron (II) sulphate
Chromium (II) sulphate
Borax

Procedure

Make a small loop at the end of a platinum wire. Heat the loop in an oxidizing flame until it is red hot and touch some borax with it. Introduce the wire, along with the adhering borax into the flame. Note carefully the changes that take place. The borax first swells and later fuses to give a glass-like, transparent bead. Touch some copper sulphate crystals with the hot bead and heat it again in an oxidizing flame until it becomes transparent. Note the colour of the bead when it is hot and also when it is cold. Then place the bead in the central zone of the reducing flame and heat it for about 2 minutes. Remove the bead from the flame and observe the colours in the hot and cold conditions. Clean the platinum wire by melting the bead and shaking it off from the wire. Dip the hot wire in borax and heat it in the flame and shake off the bead so formed again. Repeat this until no coloured bead is obtained. Carry out the experiment with the other substances and record the colour of the bead in each case. Tabulate as follows.

Substance	Colour of the bead			
	Oxidizing flame		Reducing flame	
	Hot	Cold	Hot	Cold

12

Ammonia

Materials required

Hard glass test tube
Retort stand with clamp
One holed cork with delivery tube
Card board disc
Gas-collecting tubes with corks 4
Boiling tube
Two holed rubber stopper
Narrow glass tube
Short bent tube
Glass rod
Mortar and pestle
Burner
Test tube
Beaker (250 ml)
Splinter

Ammonium chloride
Dry slaked lime
Litmus papers (blue and red)
Turmeric paper
Phenolphthalein
Concentrated hydrochloric acid
0.1 M copper (II) sulphate
0.1 M iron (III) chloride

Procedure

Mix 6 g of powdered ammonium chloride, with about twice its weight of dry slaked lime in a mortar. Transfer the mixture to a hard glass test tube and clamp the tube to a retort stand in a slightly inclined position (fig. 4).

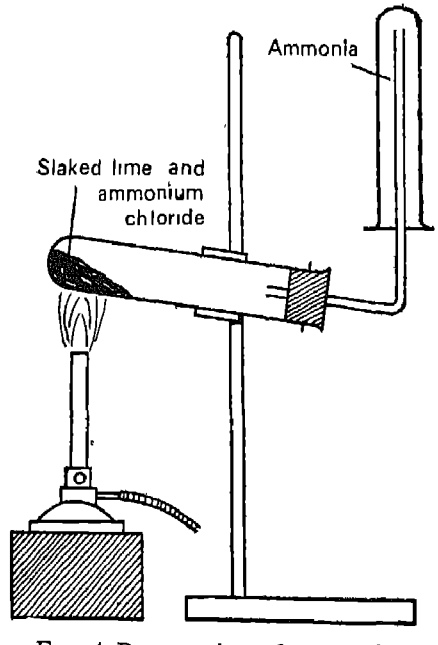

FIG. 4 Preparation of ammonia

Fit the test tube with a one-holed cork carrying a delivery tube such that the end of the delivery tube points upwards. Slip on the card board disc and invert a dry, gas-collecting tube over it, so that the tip of the delivery tube is almost near the bottom of the tube but not touching it. Heat the hard glass test tube carefully till the gas is evolved (pungent, choking smell). Collect the gas in four gas-collecting tubes and cork them.

Place about 10 ml of water in a boiling tube. Fit the tube with a two-holed rubber stopper. Pass a long, narrow glass tube through one hole and a short bent tube through the other (fig. 5).

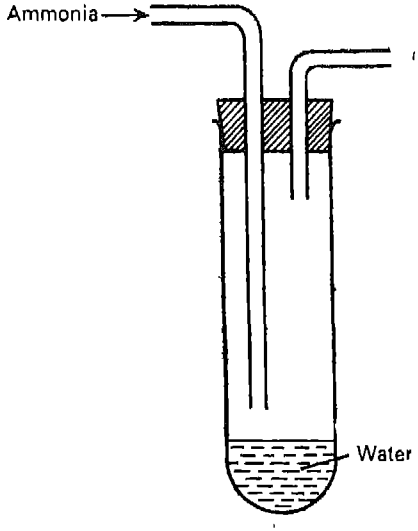

FIG 5 Preparation of aqueous ammonia

Connect the delivery tube of the ammonia generator to the bent tube and pass the gas for about 2 minutes. Aqueous ammonia is formed. Preserve this solution for testing at a later stage.

Introduce moist turmeric paper and litmus papers into one of the tubes containing ammonia gas. Note what happens.

Place about 200 ml of water in a 250 ml beaker. Add 2 to 3 drops of phenolphthalein to it Invert a tube containing ammonia gas into the water and remove the cork. Observe what happens. What do you infer?

Dip a glass rod in concentrated hydrochloric acid and insert it into a tube containing ammonia. Note what happens.

Hold one tube containing ammonia gas in an inverted position. Remove the cork and insert a burning splinter into it. Note what happens. What do you conclude?

Take 1 ml of copper (II) sulphate solution in a test tube. Add aqueous ammonia (prepared earlier) dropwise and then in excess. Note what happens.

Repeat the test with iron (III) chloride solution. Record your observation.

Questions

1. Is ammonia a base or an acid?
2. Write equations for the reactions studied.

13

Hydrogen sulphide

Materials required

Test tubes 6
Test tube holder
Test tube stand
Bunsen burner

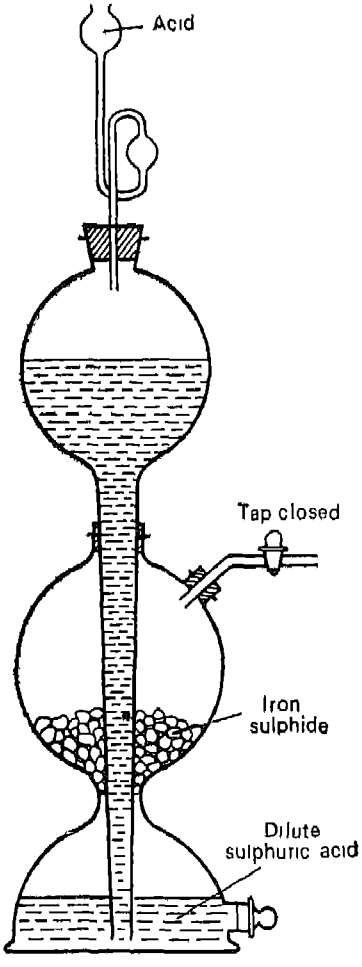

FIG. 6 Kipp's apparatus

0 1 M solutions of
lead acetate
potassium permanganate
potassium dichromate
copper (II) sulphate
cadmium sulphate
lead nitrate and
antimony nitrate
1.0 M nitric acid
1.0 M sulphuric acid
Litmus papers (blue & red)
Filter paper strips

Caution

Hydrogen sulphide is poisonous. Avoid inhaling the gas.

Procedure

Collect hydrogen sulphide gas in a test tube from the Kipp's apparatus (fig. 6) provided and carry out the following tests.

Note the colour and smell of the gas. Test the gas with lead acetate paper (a strip of filter paper dipped in lead acetate solution) by holding it near the mouth of the test tube. Note what happens.

Pass the gas into a test tube containing about 5 ml of water. Test the solution with red and blue litmus papers. Record the observations. Boil the solution for about 3 to 5 minutes and test the solution with litmus papers again. What do you infer?

Place 2 ml of potassium permanganate solution in a test tube. Add a few drops of dilute sulphuric acid and pass hydrogen sulphide gas. Note what happens.

Repeat the above test using solutions of potassium dichromate, copper (II) sulphate, cadmium sulphate, antimony nitrate and lead nitrate (use dilute nitric acid in place of dilute sulphuric acid for acidifying lead nitrate solution).

14

Sulphur dioxide

Materials required

Test tubes 2

Test tube holder

Sodium sulphite

2 0 M hydrochloric acid

Litmus papers (red & blue)

0.1 M potassium dichromate acidified with dilute sulphuric acid

0.1 M potassium permanganate acidified with dilute sulphuric acid

Filter paper strips

Procedure

Take about 1g of sodium sulphite in a test tube Add to it 1ml of dilute hydrochloric acid. Sulphur dioxide gas is evolved. Note the colour of the gas. Gently waft the gas towards you and smell it. *Do not inhale.*

Hold moist blue litmus paper near the mouth of the test tube Note what happens. Repeat the test with moist red litmus paper.

Hold a filter paper strip dipped in acidified potassium dichromate solution near the mouth of the test tube. Note what happens.

Repeat the test with a filter paper strip dipped in acidified potassium permanganate solution. Note what happens.

Question

Is sulphur dioxide acidic or basic in nature?

15

Molar volume of a gas

Materials required

Flat bottomed flask (250 ml)
Glass tubes bent at right angles 2
Rubber tubes (10 cms long) 2
Screw clips 2
Two-holed rubber stopper
Balance
Weight box
Measuring cylinder (250 ml)
Carbon dioxide generator
U-tube containing anhydrous $CaCl_2$

Marble chips

2.0 M hydrochloric acid

Procedure

Close the mouth of a 250 ml flat bottomed flask with a two-holed rubber stopper. Pass two glass tubes, each bent at right angles, through the holes. One tube reaches almost to the bottom of the flask while the

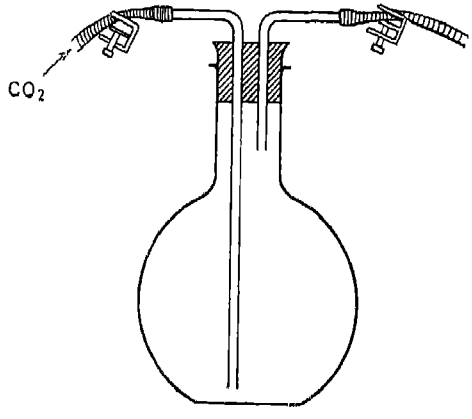

FIG. 7 Apparatus for determining the molar volume of a gas

other just passes through the stopper Attach a rubber tube to each of the glass tubes. Place a screw clip on each of the rubber tubes (fig.7). Weigh this entire set up to the nearest centigram and record the weight.

Generate carbon dioxide gas using a Kipp's apparatus. Dry the gas by passing it through a U-tube containing anhydrous calcium chloride Pass the gas into the flask through the glass tube extending almost to the bottom of the flask. Pass enough carbon dioxide to sweep out all the air present in the flask. Close tightly the clip on the rubber tube connected to the carbon dioxide source first and the clamp on other tube later. Determine the weight again and record.

Note the room temperature and the barometer reading. Repeat the process of passing carbon dioxide and weighing until the weight is constant (within 0.1 g).

Remove the stopper and tubes and fill the flask with water. Measure and note the volume of the water in the flask.

Readings and calculations

The volume of the water that fills the flask is the volume of carbon dioxide or of air present. Reduce this volume to standard temperature and pressure (S.T.P.).

Air at S.T P. has a mass of 1 29 g/litre. Calculate the mass of the air in the flask.

Mass of the empty flask = Mass of flask with air—mass of air filling the flask

Mass of the carbon dioxide = Mass of the flask filled with carbon dioxide—mass of empty flask

The formula of carbon dioxide is CO_2. Calculate its molar weight.

The mass and volume of carbon dioxide filling the flask are known. Calculate the volume occupied, at S.T.P., by one mole of the gas. Express the value in litres.

16

Heat of neutralization

Materials required

Beaker (600 ml)
Beaker (250 ml)
Thermometer (—10 to 110°/1°C)
Glass rod
2 0 M sodium hydroxide
2.0 M hydrochloric acid

Procedure

Measure out 200 ml of hydrochloric acid solution into a clean, dry 600 ml beaker. Measure out 200 ml of sodium hydroxide solution into a 250 ml beaker. Note the temperatures of the two solutions. Add the the sodium hydroxide to the acid. Stir well and record the highest temperature reached. Calculate the heat of neutralization.

Calculations

Assume the density of the solutions to be 1 g/ml

Temperature of the acid solution $=t_1^\circ C$

Temperature of the alkali solution $=t_2^\circ C$

Initial temperature $= \left(\frac{t_1+t_2}{2} \right)^\circ C = t^\circ C$

Final temperature (after mixing the solutions) $=t^\circ C$

$\therefore$ Rise in temperature $=(t_3-t)^\circ C$

Heat liberated during the neutralization $=400 \times 1\ (t_3-t)$ cal

In this reaction 0 4 mole of hydrochloric acid has neutralized 0.4 mole of sodium hydroxide to liberate 400 (t_3-t) calories of heat.

Hence, the heat liberated when 1 mole of acid neutralizes 1 mole of base $= 400(t_3-t) \times \frac{5}{2}$ calories

Express the heat of nuetralization in kcals per mole.

17

Heat of combustion

Materials required

Tin can

Spirit lamp

Ethanol

Measuring cylinder (100 ml)

Thermometer (—10 to 110°/1°C)

Balance

Weight box

Ice

Glass rod

Procedure

Place 250 ml of water in a tin can. Fill a spirit lamp with ethanol and weigh it. Note the temperature of the cold water. Light the spirit lamp and place it under the can. Stir the water continuously till the temperature rises by about 20 C. Put out the spirit lamp, stir the water and record the temperature again. Reweigh the spirit lamp.

Calculations

Initial weight of the spirit lamp + ethanol	$=W_1$g
Final weight of the spirit lamp + ethanol	$=W_2$g
∴ Weight of ethanol burnt	$=(W_1—W_2)$g
Molecular weight of ethanol	$=46.0$
Weight of water taken	=250 g (assume density of water to be 1 g/ml)

Initial temperature of water	$=t_1°C$
Final temperature of water	$=t_2°C$
$\therefore$ Temperature rise	$=(t_2-t_1)°C$
Heat absorbed by water*	$=250 \times 1 \ (t_2-t_1)$ calories

This is the heat evolved when (W_1-W_2)g of ethanol is burnt.

(W_1-W_2) g of ethanol, on combustion, liberates 250 (t_2-t_1) calories of heat.

46 g (i.e. 1 mole) of ethanol liberates $\frac{250\ (t_2-t_1)}{(W_1-W_2)} \times 46$ calories

$\therefore$ Heat of combustion of ethanol $= \frac{250\ (t_2-t_1)46}{(W_1-W_2)}$ calories/mole

Express the value in kcals/mole.

* Heat absorbed by the container and heat loss due to radiation are neglected.

18

Heat changes in chemical reactions

Materials required

Beaker (250 ml)

Glass rod

Thermometer (—10 to 110°/1°C)

Piece of wood
(10 cm x 10 cm x 1 cm)

Balance

Weight box

1.0 M copper (II) chloride

Aluminium foil

Barium hydroxide

Ammonium thiocyanate

Procedure

(a) Take 100 ml of copper (II) chloride solution in a 250 ml beaker. Note the temperature of the solution. Put an aluminium foil in the solution. Stir well and record the temperature. Observe the surface of the foil and record the changes. Write the chemical equation for the reaction.

(b) Place the given quantities of solid barium hydroxide and ammonium thiocyanate in a beaker. Sprinkle a small quantity of water on a block of wood and place the beaker on the block. Mix the two solids thoroughly with a glass rod for several minutes. Lift the beaker. What happens? Explain your observation.

19

Concentration and reaction rate

Materials required

Conical flask (100 ml)
Measuring cylinder (50 ml)
Measuring cylinder (10 ml)
Beaker (100 ml)
Stop watch
Graph papers 2

2.0 M hydrochloric acid
0.2 M sodium thiosulphate

Procedure

Measure out 50 ml of sodium thiosulphate solution into a conical flask. Add 5 ml of hydrochloric acid to it and simultaneously start the stop watch. Gently swirl the solution and place the conical flask over a cross (x), marked on a sheet of white paper. Observe the cross mark through the solution from the top and stop the watch when the mark just becomes invisible. Record the time elapsed. The following reaction takes place.

$$S_2O_3^{--}(aq) + 2H^+(aq) \longrightarrow H_2O\ (l) + SO_2(g) + S(s)$$

The sulphur precipitated masks the mark. (The time taken for masking is taken as the time required for the reaction to occur).

Repeat the experiment using 40, 30, 20 and 10 ml of the thiosulphate solution made up, in each case, to a total volume of 50 ml by adding water.

Plot

(i) concentration of the thiosulphate solution against time. the volume of the the original thiosulphate may be taken as a measure of its concentration).

(ii) concentration of the thiosulphate solution against reciprocal of time.

Question

What conclusions do you draw from the graphs?

20

Temperature and reaction rate

Materials required

Conical flask (100 ml)
Measuring cylinder (50 ml)
Measuring cylinder (10 ml)
Thermometer (—10 to 110°/1°C)
Tripod
Wire gauze
Graph papers 2
Stop watch
0.1 M sodium thiosulphate
2 0 M hydrochloric acid

Procedure

Measure out 10 ml of sodium thiosulpahte solution into a conical flask and add 40 ml of water to it. Record the temperature of the solution. Add 5 ml of hydrochloric acid to the thiosulphate solution and simultaneously start the stop watch. Gently swirl the solution and place the conical flask over a cross (x), marked on a sheet of white paper. Observe the cross mark through the solution from the top and stop the watch when the mark just becomes invisible. Record the time elapsed.

Empty the conical flask and wash it thoroughly. Measure out, again, 10 ml of sodium thiosulphate solution into the flask and add 40 ml of water to it. Heat the solution gently (with a small flame and with constant shaking) to 35°C. Remove the conical flask from the flame, add 5 ml of hydrochloric acid and simultaneously start the stop watch. Keep the conical flask over the cross mark and note the time required for the mark to become invisible.

Repeat the experiment as above at temperatures of 40°C, 45°C and 50°C and note the time in each case.

Plot (i) the time taken against the temperature and (ii) the reciprocal of time against temperature.

Question

What conclusions do you draw from the graphs?

21

Catalyst and reaction rate

Materials required

Beaker (400 ml)
Eudiometer tube (50 ml)
Graduated pipette
Iron stand with clamp
Rubber tubing 50cm
Stop watch
Conical flask 100 ml
One-holed rubber stopper carrying a bent glass tube
Graph paper

Hydrogen peroxide (20 vol)
Manganese (IV) oxide
Mercury (II) oxide
Copper (II) oxide

Procedure

Fill a beaker about three quarters full with water. Fill an eudiometer tube completely with water and set up the apparatus as shown in fig. 8.

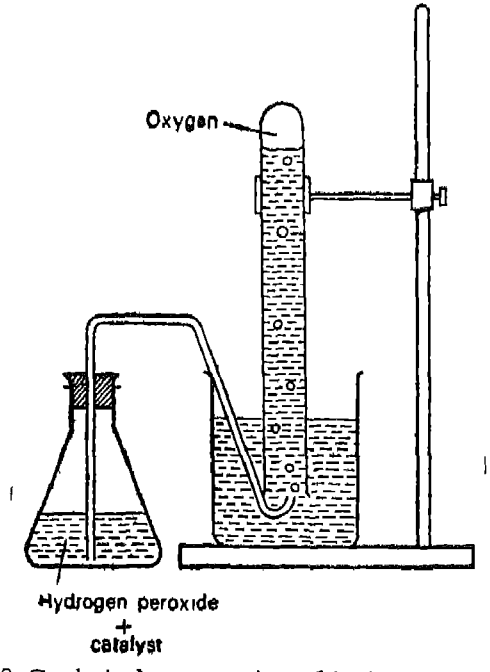

FIG. 8 Catalytic decomposition of hydrogen peroxide

Measure out 50 ml of water into a conical flask, close its mouth with a one-holed rubber stopper carrying a delivery tube. Insert the other end of the delivery tube into the mouth of the eudiometer tube as shown in the figure.

Remove the stopper of the conical flask, add 2 ml of hydrogen peroxide solution and immediately replace the stopper, starting the stop watch simultaneously. Gently swirl the solution and note the volume of oxygen evolved at 2 minute intervals for 10 minutes. Now add about 0.2 g of manganese (IV) oxide to the hydrogen peroxide solution and continue measuring the volume of oxygen evolved at 2 minute intervals for 20 minutes more. Plot the volume of oxygen evolved against time. Compare the rate of evolution of oxygen before and after the addition of manganese (IV) oxide. Repeat the experiment using mercury (II) oxide and copper (II) oxide.

Question

Which of the three oxides used is most effective as a catalyst for this reaction?

22

Factors affecting the rate of reaction

Materials required

Graduated test tubes 2	0 02 M potassium permanganate
Test tubes 2	0.1 M iron (II) ammonium sulphate
Test tube stand	0 05 M oxalic acid
Boiling tube	2.0 M sulphuric acid
Measuring cylinders (25 ml) 3	Solution A—0.2 M potassium iodide (containing starch)
Conical flask (150 ml)	Solution B—0.005 M sodium thiosulphate
Water bath	Solution C—0.1 M ammonium peroxydisulphate
Tripod	
Dropper	
Thermometer (—10 to 110°/1°C)	0.01 M copper (II) sulphate

Procedure

(*A*) *Nature of reactant*

Take 2 ml of potassium permanganate solution in each of two test tubes and add 2 ml of sulphuric acid to each. Then add simultaneously 3 ml of iron (II) ammonium sulphate solution to one test tube and 3 ml of oxalic acid solution to the other. Shake the tubes well and observe in which test tube, the purple colour of the permanganate solution disappears first.

(*B*) *Concentration*

Label three measuring cylinders as A, B and C. Use them for measuring the solutions A, B and C respectively. Measure out 20 ml of solution A and 10 ml of solution B into a conical flask. Add 20 ml of solution C to it, simultaneously starting the stop watch. Swirl the solution. Stop the watch when a blue colour appears suddenly. Note the time taken for the appearance of the blue colour.

Repeat the experiment by taking 15 ml of solution A, 5 ml of water and 10 ml of solution B in the conical flask. Now add 20 ml of solution C and note the time required for the appearance of the blue colour. Repeat with varying volumes of solution A as shown in the table given below.

Sl. No.	Volume of solution A in ml	Volume of water in ml	Volume of solution B in ml	Volume of solution C in ml	Time in sec.
1.	20	0	10	20	..
2.	15	5	10	20	..
3.	10	10	10	20	..
4.	5	15	10	20	..

(*C*) *Temperature*

Measure out 5 ml of solution A into a conical flask. Add 5 ml of water to it and then 10 ml of solution B. Take 10 ml of solution C in boiling tube. Keep the conical flask and the boiling tube in a water bath for about 10 minutes. Note the temperature of the water bath. Now add solution C (in the boiling tube) to the contents of the conical flask simultaneously starting the stop watch. Swirl the solution well. Stop the watch as soon as a blue colour appears. Note the time required for the appearance of the blue colour

Measure out again the solutions into the conical flask and the boiling tube as described above. Keep both in the water bath. Heat the water bath gently with a small flame to a temperature of 35°C. Maintain the water bath at this temperature Now add solution C (in the boiling tube) to the contents of the conical flask, simultaneously starting the stop watch. Note the time required for the appearance of the blue colour.

Repeat the experiment at 40° and 45°c. Record your observations in a table as shown below.

S. No.	Temperature	Time required in sec.
1.	room temperature	..
2.	35°	..
3.	40°	..
4.	45°	..

(*D*) *Catalyst*

Measure out 10 ml of solution A into a conical flask. Add 10 ml of water and 10 ml of solution B to it. Now add 4 drops of copper (II) sulphate solution (catalyst) to it. Add 20 ml of solution C to the mixture in the flask, simultaneously starting the stop watch. Swirl the solution. Stop the watch when a blue colour appears suddenly. Note the time taken for the appearance of the blue colur. Compare this time with the time required for solutions of the same concentration in B.

Questions

1. How does a change in the concentration of solution A affect the time required for the blue colour to appear? What does this mean in terms of the reaction rate?

2. How does an increase in the concentration of solution C affect the reaction rate?

3. What is the effect of temperature on the reaction rate?

23

Reversible systems-I

Materials required

Test tubes 2

Measuring cylinders (10 ml) 2

1.0 M potassium iodide

Carbon tetrachloride

Iodine crystals

Procedure

Place 2 ml of potassium iodide solution in one test tube and 2 ml of carbon tetrachloride in another. Take two iodine crystals of about the same size and add one crystal to each test tube. Shake well until the crystals dissolve. Note the colour of the two solutions.

Add 2 ml of carbon tetrachloride to the solution of iodine in potassium iodide. Without disturbing the two layers note the colour of the carbon tetrachloride layer (The carbon tetrachloride layer sinks to the bottom). Shake the test tube gently and note the colour of the carbon tetrachloride layer. Shake vigorously and note the colour again.

Repeat the experiment by adding 2 ml of potassium iodide solution to the iodine solution in carbon tetrachloride. Note the colour of the potassium iodide layer first without shaking, then with gentle shaking and finally with vigorous shaking. Compare the intensities of the colours of the different layers in both the test tubes. What do you find?

24

Reversible systems-II

Materials required

Test tubes 4

Glass rod

Test tube stand

Droppers 3

Bismuth chloride

12.0 M hydrochloric acid

Procedure

(*A*)

Place about 0.5 g of bismuth chloride in a test tube. Add hydrochloric acid dropwise till the solid just dissolves. (Avoid excess acid).

Fill a test tube two-thirds full with water and add a few drops of bismuth chloride solution. What happens? Now add a few drops of hydrochloric acid. Stir and record your observations.

(*B*)

Fill three test tubes, each two-thirds full with water. Add 5 drops of hydrochloric acid to the first test tube, 10 to the second, and 15 to the third and stir. Then add 5 drops of bismuth chloride solution to each test tube. Record your observations.

25

Chemical equilibrium

Materials required

Beaker (150 ml)	0.002 M ammonium thiocyanate
Test tubes 6	Iron (III) chloride solution (5%)
Measuring cylinder (25 ml)	Ammonium thiocyanate (solid)
Glass rod	Sand

Procedure

Place 25 ml of ammonium thiocyanate solution in a beaker. Add to it four or five drops of iron (III) chloride solution and stir well. The following equilibrium is set up.

$$\underset{\text{Pale yellow}}{2\,FeCl_3} + \underset{\text{colourless}}{6NH_4SCN} \rightleftharpoons \underset{\text{deep red}}{Fe\,[Fe(SCN)_6]} + \underset{\text{colourless}}{6\,NH_4Cl}$$

$$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons FeSCN^{2+}(aq)$$

Add about 50 ml of water to the beaker and stir well. Take 5 ml of this solution in each of six test tubes. Keep one test tube aside for reference.

To one of the test tubes add a few crystals of ammonium thiocyanate. Stir well and note the change, if any, in the intensity of the colour of the solution.

Similarly add the following substances to each of the other test tubes, shake and note if there is any change in the intensity of the colour.

(i) a few drops of iron (III) chloride solution,
(ii) solid ammonium chloride,
(iii) about 2g of ammonium nitrate and
(iv) a little sand.

Compare the colour in each of the above test tubes with the colour of the solution in the test tube kept aside for reference.

Is there a shift in the equilibrium position in each of the above test tubes? If so, indicate the direction in which it is shifted as a result of addition of the substance.

26

Melting point of a solid

Materials required

Sulphuric acid bath

Benzoic acid

Thermometer (0 to 360°C)

Iron stand with clamp

Wire gauze

Tripod

Burner

Test tube brush

Capillary tubes

Watch glass

Procedure

Take a capillary, about 5 cm long, and seal off one of its ends by heating in a burner. Take a finely powdered sample of the given solid on a clean, dry watch glass. Press the open end of the capillary into the powder. A small quantity of the substance gets into the capillary. Holding the capillary in a vertical position,with its open end pointing upwards, gently rub its upper end with the handle of a test tube brush. The substance falls to the bottom of the capillary. Repeat the process until the substance collects in the capillary to a depth of about 1 cm. To ensure close packing tap the capillary gently.

Wet the closed end of the capillary with sulphuric acid and attach it to the bulb of a thermometer. The capillary sticks to the thermometer

Lower the thermometer carefully into concentrated sulphric acid in a test tube, which, in turn, is kept in a flat-bottommed flask containing

concentrated sulphuric acid (fig. 9). Keep this bath on a wire gauze kept on a tripod. Clamp the bath to a stand.

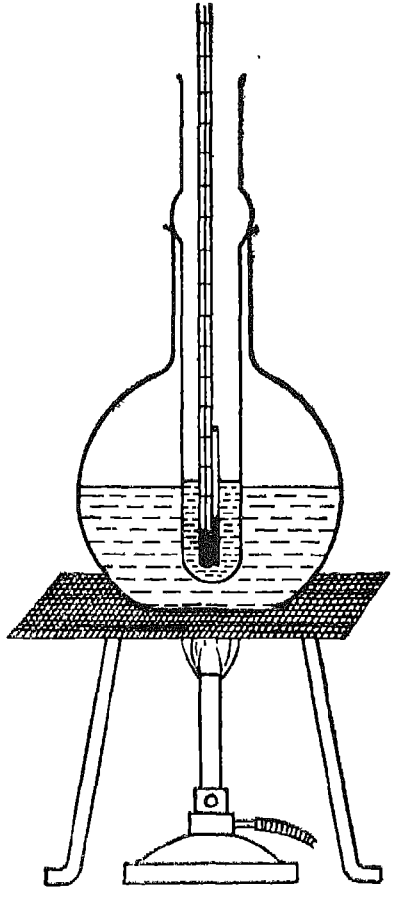

FIG. 9 Melting point apparatus

Caution: Concentrated sulphuric acid should be handled carefully.

Heat the bath gently. When the substance in the capillary just melts, record the temperature. This gives the melting point of the solid.

27

Boiling point of a liquid

Materials required

Beaker (250 ml)
Thermometer (0 to 360°C)
Iron stand with clamp
Ignition tube
Capillary
Burner
Wire gauze
Tripod

Rubber band

Acetone

Procedure

Take about 200 ml of concentrated sulphuric acid in a 250 ml beaker. Place it on a wire gauze resting on a tripod.

Place about 1 ml of the given liquid in an ignition tube.

Take a capillary, about 8 cm long, and seal off one of its ends. Dip the open end of the capillary into the liquid contained in the ignition tube Attach a thermometer to the ignition tube with the help of a rubber band (fig. 10). See that the bulb of the thermometer and the open end of the capillary are at the same level and the rubber band well above the surface of the bath liquid (acid).

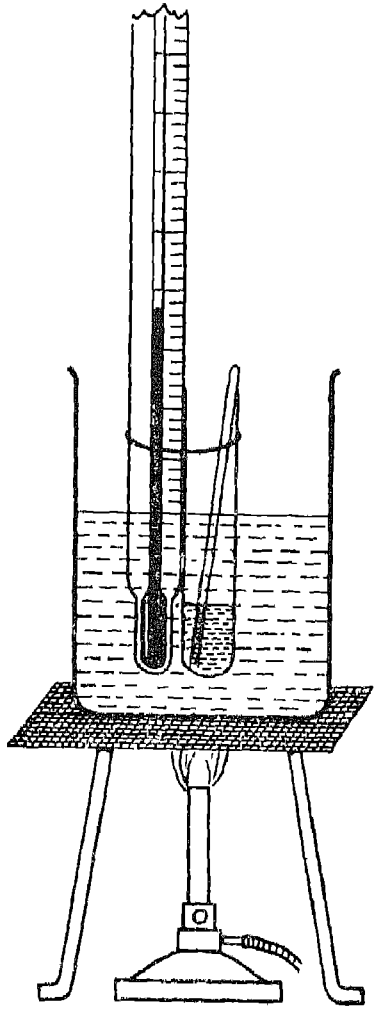

Fig. 10 Boiling point apparatus

Heat the acid bath gently. Bubbles are seen to pass through the liquid in the ignition tube. When a constant flow of bubbles through the liquid is observed, note the temperature. This gives the boiling point of the liquid

Alternate method

Materials required

Boiling tube
One-holed cork
Iron stand with clamp
Thermometer (0 to 360°C)
Porcelain pieces
Burner
Carbon tetrachloride

Procedure

Place about 5 ml of the given liquid and one or two small porcelain pieces in a boiling tube. Take a one-holed cork and cut a narrow slit along its length. Pass a thermometer through the hole in the cork. Fit the mouth of the boiling tube with the cork See that the bulb of the thermometer is above the surface of the liquid (fig. 11). Clamp the tube to a stand. Heat it gently first with a sooty flame and then with a non-luminous flame. When the thermometer records a constant reading for about a minute, note the temperature and record it

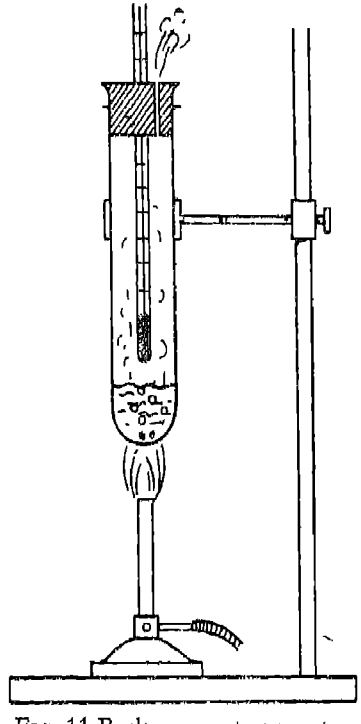

FIG. 11 Boiling point apparatus

28

Heat of solution

Materials required

Conical flask (250 ml)
Balance
Weight box
Thermometer (—10 to 110°/1°C)
Measuring cylinder (100 ml)
Sodium hydroxide
Ammonium chloride

Procedure

Weigh a clean, dry conical flask to the nearest 0.1g. Place 100 ml of water in it and record the temperature of the water.

Weigh quickly about 2g of solid sodium hydroxide. (Sodium hydroxide becomes moist when weighed in open air). Add the sodium hydroxide to the water in the conical flask. Swirl the flask until the sodium hydroxide is dissolved. Record the maximum temperature of the solution. Calculate the heat of solution as shown below.

Calculations

Weight of the conical flask	=	w_1 g
Volume of the solution	=	100 ml
Initial temperature of water	=	t_1°C
Final temperature of the solution	=	t_2°C
The specific heat of glass is 0.18		
Heat evolved by dissolving sodium hydroxide in water	=	$(w_1 x 0.18+100)$ $(t_2—t_1)$ calories

Calculate the heat of solution per mole of sodium hydroxide. Repeat the experiment by using solid ammonium chloride instead of sodium hydroxide and calculate the heat of solution per mole of ammonium chloride.

29

Preparation of a standard solution

Materials required

Funnel
Standard flask (250 ml)
Weighing bottle
Balance
Weight box

Sodium chloride

Procedure

Weigh accurately about 1.5 g of the given sample of sodium chloride by the method of difference. Transfer the weighed sample to a funnel kept over a 250 ml standard flask (fig. 12) Wash down the sample carefully into the flask by a jet of water using a wash bottle. See that no particle of the salt sticks to the funnel. Wash the sides of the funnel with small amounts of water two or three times (into the flask). Remove the funnel and swirl the flask gently till the solid dissolves completely. Now add water to the flask upto the mark on the stem of the flask. (See that the lower meniscus of the solution coincides with the mark). Stopper the flask and shake well for the solution to acquire uniform concentration. What is the molarity of this standard solution?

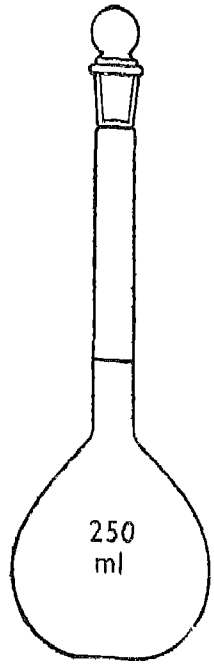

FIG 12 Standard flask

Questions

1. Calculate the quantity of sodium chloride required to prepare the following.
   (i) 250 ml of 0.01 M
   (ii) 500 ml of 0.1 M
   (iii) 1000 ml of 0.1 M
   (iv) 1000 ml of 0.2 M
2. Calculate the molarity of the following solutions.
   (a) 0.53 g of Na_2CO_3 present in 100 ml of solution.
   (b) 5.85 g of NaCl present in 500 ml of solution
   (c) 10 g of NaCl present in 1 lit of solution
   (d) 10 g of Na_2CO_3 present in 1 lit of solution.

30

Determination of molecular weight

Materials required

Capillary

Melting point bath

Tripod

Iron stand

Wire gauze

Thermometer (0 to 360°C)

Sample of powdered mixture

Sample of pure camphor

Procedure

Take the given powdered mixture in a capillary (see experiment 26) and determine its melting point. Similarly determine the melting point of a sample of pure camphor. The difference between the two temperatures gives the lowering of melting point of camphor The weight of the given substance dissolved in a definite weight of camphor will be supplied to you. Calculate the molecular weight of the given substance using the equation given below.

$$m = \frac{1000\ k_f\ w_1}{w_2\ (\triangle T_f)}$$

k_f is the molar depression constant, which for camphor is= 40°C

w_1 is the weight, in grams, of the given substance dissolved in w_2 g of camphor.

$(\triangle T_f)$ is the observed depression of the melting point

31

Colours of indicators in solutions of different pH

Materials required

Test tubes 3
Test tube stand
Droppers 5
Measuring cylinder (10 ml)

Bromthymol blue
Methyl orange
Methyl red
Phenolphthalein
Universal indicator
Solutions of pH 3, 7 and 11

Procedure

Lable three test tubes as 1, 2 and 3 and place them in a test tube stand.

Place 5 ml each of solutions of pH 3, 5 and 7 in test tubes 1, 2 and 3 respectively. To each of these tubes add one drop of bromthymol blue indicator. Record the colour of the solutions in each test tube.

Wash the test tubes thoroughly and repeat the experiment as above using different indicators and record the colour in each case. Tabulate your observations as follows.

Indicator	Colour of the indicator in solutions of pH		
	3	7	11
Bromthymol blue Methyl orange Methyl red Phenolphthalein Universal indicator			

32

Determination of pH

Materials required

Measuring cylinder (10 ml)

Test tubes 4
Test tube stand
Dropper

1.0 M and 0.1 M solutions of
ammonium acetate,
ammonium chloride,
sodium carbonate and
sodium chloride
Universal indicator

Procedure

Place 5 ml of 1.0 M ammonium acetate solution in a test tube and add a drop of universal indicator to it. Shake the test tube Match the colour of the solution with a pH range colour chart and record the approximate pH of the ammonium acetate solution. Repeat the experiment with 0.1 M ammonium acetate solution and also with 1.0 M and 0.1 M solutions of ammonium choloride, sodium carbonate and sodium chloride. Tabulate your results as follows:

No.	Salt solution	Concentration	Approximate pH	Nature of the solution (acidic, basic, neutral)
1.	Ammonium acetate	1.0 M 0.1 M		
2.	Sodium chloride	1.0 M 0.1 M		
3	Sodium carbonate	1.0 M 0.1 M		
4.	Sodium chloride	1.0 M 0.1 M		

33

Separation of the constituents of ink

Materials required

Beaker (250 ml)
Dropper
Pair of scissors
Filter paper circle (10 cm)
Ink

Procedure

Take a filter paper circle and make two cuts with a pair of scissors from the edge of the filter paper to the centre to get a strip of paper about 0.3 cm wide as shown in fig. 13. Bend the strip from the centre of the paper so that it is at right angles to the rest of the filter paper.

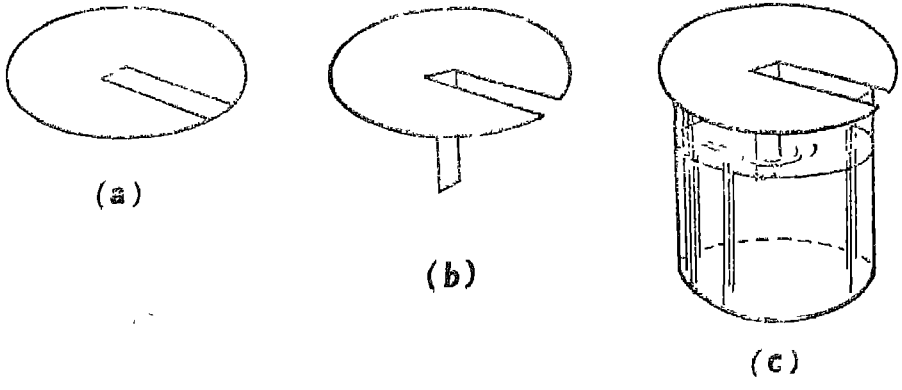

FIG. 13. Chromatographic separation

With the help of the dropper place a drop of ink on the strip near the bent portion. When the spreading of the ink stops place another drop. Allow the ink to dry. Place the filter paper on the top of a beaker containing distilled water See that the end of the strip dips in water. Keep the arrangement in a place where there is no wind. After half an hour observe the filter paper. Leave it for 4 or 5 hours and again observe the filter paper and note the number of rings formed,

34

Displacement reactions

Materials required

Magnesium ribbon (10 cm)
Strips (10 cm x 1 cm) of
aluminium
zinc
iron
lead
copper
Test tubes 6
Test tube stand
Sand paper

0.5 M aqueous solutions of
magnesium sulphate
zinc sulphate
iron (II) sulphate
lead nitrate
copper (II) nitrate

Procedure

Fill about three-fourths of each of six test tubes with copper (II) nitrate solution and keep them in a test tube stand.

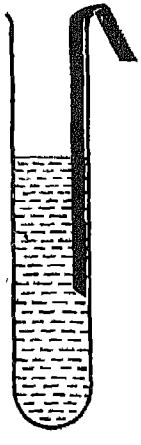

FIG.14. Displacement of metals,

Obtain five metal strips, one each of aluminium, zinc, iron, lead and copper and a magnesium ribbon. Rub their surfaces with sand paper to obtain a bright surface. Bend each one of them into the shape 'J' so that they can be hung from the rim of a test tube (Fig. 14). Place each strip separately in each of the test tubes containing copper (II) nitrate solution, so that about half the length of the strip is dipped in the solution.

Take the metal strips out of the solution after about 3 minutes and observe the change, if any, on their surfaces. Compare the dipped and undipped portions of the metal strips to find if any change has ocurred. Record which metals show observable change on their surfaces.

Empty the test tubes and wash them thoroughly. Fill them, this time, with zinc sulphate solution. Wash and clean the metals thoroughly (with sand paper) and place them, one each in the six test tubes containing zinc sulphate solution. Observe for any change on their surfaces after about 3 minutes.

Repeat the experiment with magnesium sulphate, lead nitrate and iron (II) sulphate solutions and record your observations.

Find which metal displaces another metal from the solution of a salt of the latter. Arrange the metals, in the decreasing order of their displacing capacity.

35

Electromotive series

Materials required

Beaker (150 ml)
Magnesium ribbon (10 cm)
Strips (10 cm x 1 cm) of
- zinc
- iron
- lead
- copper
- silver

Connecting wires
Crocodile clips 2
Voltmeter (0—5 volts)
1.0 M sodium chloride

Procedure

Fill a beaker to about two-thirds with sodium chloride solution. Place a zinc strip and a copper strip in it. See that the two strips are not in direct contact with each other (fig. 15). Connect the strips to the terminals of a voltmeter and record the voltage. Do not allow the current to flow for more than a few seconds

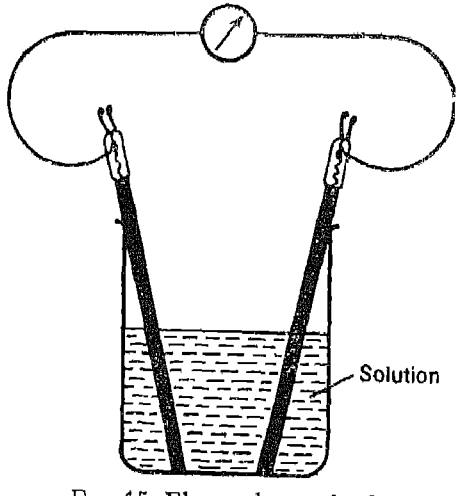

FIG. 15. Electrochemical cell

Note:—If the needle deflects to the left of the zero reading in the voltmeter interchange the terminals and record the voltage.

Repeat the experiment using the other metals in turn separately in place of the zinc strip. Record the voltage for the combination of each one of the metals with copper.

Prepare a list of the various combinations in the decreasing order of voltage

Question

What conclusions do you draw about the displacement of the metals used in the experiment by one another?

36

Some reactions of alcohols

Materials required

Test tubes 4
Test tube holder
Test tube stand
Dropper
Tripod
Water bath
Burner
Thermometer (—10 to 110°C/1°)
Beaker (250 ml)
Glass rod
Litmus papers (red and blue)
Methyl alcohol
Ethyl alcohol
Salicylic acid
Sodium acetate
Sulphuric acid (conc)
Iodine
0.5 M potassium hydroxide

Procedure

Take about 0.5 ml of methyl alcohol in a test tube. Test with red and blue litmus papers and record your observations. Add a small amount of salicylic acid (about 0.2 g) and a few drops of concentrated sulphuric acid to the test tube and warm it gently. Cool and pour the contents of the test tube into a small amount of water taken in a beaker and stir. Smell the contents of the beaker.

Take about 0.5 ml of ethyl alcohol in a test tube. Test with red and blue litmus papers and record your observations. Add a small quantity of sodium acetate (about 0.2 g) and a few drops of concentrated sulphuric acid to the test tube and heat it gently for about a minute. Cool and pour the contents of the test tube into a beaker containing a small amount of water and stir. Smell the contents of the beaker.

Take about 1 ml of ethyl alcohol in a test tube. Add a small quantity (about 0.4 g) of powdered iodine. Warm the tube gently on a water bath to about 60°C and add potassium hydroxide solution dropwise until the solution turns yellow. Record your observation.

Repeat the above reaction with methyl alcohol and record your observation.

37

Some reactions of phenol

Materials required

Test tubes 3
Test tube holder
Dropper
Glass rod
Burner

Phenol
Sulphuric acid (conc)
Phthalic anhydride
0 1 M iron (III) chloride
Sodium hydroxide solution (10%)
Litmus papers (red and blue)

(*CAUTION: Phenol is corrosive. Handle it with care*)

Procedure

Dissolve a small amount (about 0 5 g) of phenol in about 2 ml of water. Test with red and blue litmus papers and record your observations. Add a drop or two freshly prepared iron (III) chloride solution. What happens?

Place a small quantity (about 0.5 g) of phenol in a dry test tube and add an equal quantity of phthalic anhydride. Moisten with 2 drops of concentrated sulphuric acid. Heat for about 3 to 4 minutes. *Cool well.* Then add about 5 ml of 10% NaOH solution. Record your observations.

38

Some reactions of acetaldehyde and acetone

Materials required

Test tubes 4
Beaker (250 ml)
Tripod
Wire gauze

Bunsen burner

Acetaldehyde
Acetone
2,4-dinitrophenylhydrazine solution
Fehling's solution A
Fehling's solution B
Silver nitrate solution (2%)
Aqueous ammonia (1:1)
Sodium hydroxide solution (10%)
Litmus papers (red and blue)

Procedure

Take about 1 ml of acetaldehyde in a test tube. Test with red and blue litmus papers. Record your observations. Add to it about 1 ml of 2, 4-dinitrophenyl hydrazine solution and shake vigorously. What happens? Repeat the above test using about 1 ml of acetone and record your observations.

Mix 1 ml each of Fehling's solutions A and B in a test tube. Add to it about 0.5 ml of acetaldehyde. Place the test tube in a beaker containing boiling water Set the beaker aside for about five to ten minutes. Observe what happens. Repeat the above test with acetone and record your observations.

Take about 4 ml of silver nitrate solution in a clean test tube. Add to it 2-3 drops of sodium hydroxide solution and then add aqueous ammonia drop by drop, until the grey precipitate of silver oxide first formed just dissolves. This solution is called Tollen's reagent. Take about 2 ml of this solution in each of two test tubes. Add about 0.5 ml of acetaldehyde to one test tube and about 0 5 ml of acetone to the other. Keep the test tubes in a beaker containing hot water, and allow them to stand for about five minutes. Observe what happens in each of the test tubes.

Question

Which of the above tests help to distinguish between acetaldehyde and acetone?

39

Some reactions of acetic acid

Materials required

Test tubes 2
Test tube holder
Beaker (100 ml)
Bunsen burner
Splinter
Acetic acid (glacial)
Sodium bicarbonate solution (5%)
Sulphuric acid (conc)
Ethyl alcohol
Litmus papers red and blue

Procedure

Take about 1 ml of acetic acid in a test tube. Test with red and blue litmus papers and record your observations. Add to it about 2 ml of sodium bicarbonate solution, and immediately introduce a burning splinter into the test tube. Note what happens. What does this indicate?

Take about 0.5 ml of acetic acid in a test tube. Add to it a few drops of concentrated sulphuric acid. Shake and add 1 ml of ethyl alcohol. Heat gently for about one minute. Cool and pour the contents of the tube into a beaker containing small amount of water and stir. Smell the contents.

40

Some reactions of carbohydrates

Materials required

Test tubes 4
Beaker (250 ml)
Droppers 2
Tripod
Wire gauze

Glass rod
Bunsen burner

Glucose
Alcoholic solution of α-naphthol
Sulphuric acid (conc)
Silver nitrate solution (2%)
Sodium hydroxide solution (10%)
Aqueous ammonia (1:1)
Fehling's solution A
Fehling's solution B
Sucrose
Starch (soluble)

Procedure

Dissolve about 2 g of glucose in about 10 ml of water. Use this solution for the following tests.

Take about 2 ml of glucose solution in a test tube. Add a few drops of alcoholic solution of α-naphthol to it and then add about 2ml of concentrated sulphuric acid with a dropper down the sides of the test tube. Note what happens.

Prepare Tollen's reagent (see experiment 38) and add to it about 0.5 ml of glucose solution. Mix the contents well and keep the test tube for about 5 minutes in boiling water contained in a beaker. Record your observation.

Mix about 1 ml each of Fehling's solutions A and B in a test tube. Add to this about 0.5 ml of glucose solution. Keep the test in a beaker containing boiling water for about five minutes. Note what happens.

Repeat the above reactions with sucrose and starch and record your observations. Compare the results of this experiment with those obtained in experiment 38. What do you conclude?

Question

Based on the above observations indicate which of the three (glucose, sucrose and starch) acts as a reducing agent.

41

Hydrolysis of sucrose

Materials Required

Test tubes 2	Sucrose
Test tube holder	Hydrochloric acid (conc)
Beaker (250 ml)	Sodium hydroxide solution (5%)
Bunsen burner	Litmus papers (red and blue)
Tripod	Fehling's solution A
Wire gauze	Fehling's solution B

Procedure

Dissolve about 1 g of sucrose in about 5 ml of water in a test tube. Add a drop or two of concentrated hydrochloric acid and boil gently for two or three minutes. Now add sodium hydroxide solution, drop by drop, until the solution just becomes alkaline to litmus. Test this solution with Fehling's solution and record your observation.

Question

Account for the behaviour of sucrose and that of the products of its hydrolysis on Fehling's solution.

42

Hydrolysis of starch

Materials required

Test tubes 2

Test tube holder

Tripod

Wire gauze

Dropper

Beaker (250 ml)

Bunsen burner

Aqueous solution of iodine
Starch solution

Hydrochloric acid (conc.)

Sodium hydroxide solution (5%)

Litmus papers red and blue

Fehling's solution A

Fehlings solution B

Procedure

Take about 1 ml of dilute solution of iodine in a test tube. Add a drop or two of starch solution to it. Note what happens Heat the test tube containing the solution. What do you observe now? Cool the test tube and observe again.

Add one or two drops of concentrated hydrochloric acid to about 5 ml of starch solution taken in a test tube and boil gently for a few minutes Add sodium hydroxide solution, drop by drop, until the solution just becomes alkaline to litmus. Test this solution with Fehling's solution and record your observations.

43

Properties of oils

Materials required

Beaker (250 ml)

Test tubes 3

Watch glass

Linseed oil

Litharge

Cottonseed oil

Solution of bromine (1 %)
Carbon tetrachloride.

Procedure

Take about 5 drops of linseed oil in a test tube. Add two drops of solution of bromine to it at a time and shake. What happens? Continue to add the solution dropwise till yellow colour persists. Record the number of drops of solution of bromine required.

Repeat the above test using cottonseed oil and record your observations.

Take about 1 ml of linseed oil in a test tube and add about 30 mg of litharge, PbO. Boil the mixture gently for about 10 minutes. Then pour the contents of the test tube on a watch glass. Keep the watch glass aside until the next laboratory period. Observe the product formed and note its colour.

Repeat the above test with cottonseed oil and record your observations.

44

Preparation of soap

Materials required

Beaker (250 ml)

Beaker (500 ml)

Glass rod

Thermometer (—10 to 110°C/1°)

Tripod

Wire gauze

Burner

Coconut oil

Ethyl alcohol

Sodium hydroxide solution (25%)

Sodium chloride solution (saturated)

Filter papers

Procedure

Take about 20 ml of coconut oil in a beaker and add to it 10 ml of ethly alcohol and 25 ml of sodium hydroxide solution. Keep the beaker in another beaker of hot water placed on a wire gauze over a Bunsen burner. Maintain the temperature of the water at about 85°C. Stir the mixture frequently with a glass rod and continue heating for half an hour. If the contents of the beaker appear to solidify add a small amount of distilled water. After this period of heating add about 150 ml of saturated sodium chloride solution. A solid mass is obtained. Cool and separate the solid and dry it by pressing between the folds of a filter paper.